

Morphometric and radiological evaluation of the stylohyoid complex in man

Heshmat S W Haroun

Professor, Department of Anatomy and Embryology, Faculty of Medicine, Cairo University, Egypt

ABSTRACT

Styloid process is a long & slender part of temporal bone. It measures 2 to 3 cms in length and lies antero-medial to the mastoid process. An elongated and abnormally angulated styloid process can compress the vital vessels and nerves close to it. This can lead to pain, foreign body sensation in the pharyngeal region, compression dysphagia, cervical pain, Eagle's syndrome. Eagle's syndrome is often misdiagnosed due to its vague symptomatology. The diagnosis relies on detail history taking, palpation of styloid process in tonsillar fossa and imaging modalities. The awareness of the embryological cause and the clinical implications of an elongated styloid process are important for accurate diagnosis and treatment

Keywords: *Eagle's syndrome, embryology, styloid process*

INTRODUCTION

The styloid process is derived from Greek word *stylos* that means "pillar". Styloid process (SP) of temporal bone is a slender projection measuring 2 to 3 cms in length which lies antero-medial to the mastoid process. The structures attached to it are stylopharyngeus (medially), stylohyoid (posteriorly), styloglossus (anteriorly) muscles; stylohyoid (tip) and stylomandibular (laterally) ligaments. The process is shielded by the parotid gland laterally. The temporal styloid process is an important anatomical landmark for surgeons, radiologists and clinicians while performing skull based surgery, on injecting local anesthetic solution, and during interpretation of CT and MRI scans. The close proximity of the styloid process to many of the vital neurovascular structures makes it clinically significant. It lies behind the pharyngeal wall in between two major vessels, the internal and external carotid arteries. Glossopharyngeal nerve lies in the postero-lateral wall of the tonsillar fossa. The facial nerve appears from the stylomastoid foramen that is somewhat postero-lateral to the base of the styloid process. Medially the important relations are internal carotid artery, sympathetic chain, internal jugular vein, accessory, hypoglossal, vagus and glossopharyngeal nerves.

Name & Address of Corresponding Author:

Dr. Heshmat S W Haroun

Professor, Department of Anatomy and Embryology,
Faculty of Medicine, Cairo University, Egypt.

Email: heshmatsabet@hotmail.com

Textbooks of anatomy describe it to be a slender process that projects downward and forward from the inferior surface of the petrous bone at its junction with the tympanic plate of the temporal bone. There

could be increase in the length of the styloid process due to ossification of the stylohyoid and stylomandibular ligament causing clinical symptoms. The knowledge of morphology of the styloid process (SP) and stylohyoid ligament (SHL) as well as their anatomical variations not only has great clinical implications but is also of academic interest.^[1]

It develops, in cartilage, from the second branchial arch. Reichert's cartilage of this arch forms styloid process, stylohyoid ligament, the lesser cornu and upper half of body of the hyoid bone. Embryologically, the hyoid apparatus develops from three osseocartilaginous elements that extend from the base of the skull to the hyoid bone: the tympanohyal, stylohyal, ceratohyal, and apohyal; cephalo-caudally. The stylohyal portion gives rise to the authentic styloid process whereas fusion and ossification of these three elements together result in long stylohyoid complex. Tympanohyal and stylohyal parts form the stylohyoid process, Ceratohyal- forms the stylohyoid ligament and Hypophy whole forms the lesser cornu horn of the hyoid bone.^[2]

Length of the Styloid Process:

The length of the styloid process, from the caudal margin of the tympanic plate of the temporal bone to its tip, has been directly measured in some studies on dry skulls or radiographs. It has been mentioned to be approximately 25 mm long.^[3] It is often denoted as elongated when it is longer than 30 mm in some reports or 33 mm in others.^[4-6] These length limits do not respect the natural variations of the SP.^[7] An average length of 4.1 ± 1.1 cm or of 5 cm is given in some researches.^[8,9] The lengths of the right and left SPs are reported to be 6.0 cm and 5.9 cm on a dry human skull, and 78 mm and 74 mm on CT images in a male with Eagle's syndrome.^[10,11] Some authors stated that elongation of SP in young adults had no correlation to gender, laterality or mandibular protrusive limitation while others mentioned that SP length had increased significantly

with the advance of age.^[12,13] Calcification of the stylohyoid and stylomandibular ligaments might be the reason behind the increased length of the process. Usually this is accompanied with symptoms such as dysphagia, odynophagia, facial pain, ear pain, headache, tinnitus and trismus, which is called as Eagle's syndrome. Two other syndromes associated with anomalous growth of the styloid process are the styloid process syndrome and the carotid artery syndrome.

Angulations of the SP:

Angulations of the SP have been assessed to range from 55° to 90.5° in the transversal plane and from 76° to 110° in the sagittal plane.^[14] The mean medial angle of SPs was determined to be $25.60^\circ \pm 2.56^\circ$ in patients with positive palpation and $15.42^\circ \pm 2.79^\circ$ in those with negative palpation in the tonsillar fossa, while the mean anterior angle of SPs was $16.86^\circ \pm 4.83^\circ$ in patients with positive palpation and $12.71^\circ \pm 3.39^\circ$ in those with negative palpation.^[15] A case of a biconcave SP bearing anterior and posterior concavities was described with a consequent constriction in its proximal part.^[1] A groove in the styloid process with an additional anterior angulation at its tip were also unusually observed.^[16]

Correlation between laterality and angulations of the SPs are occasionally met with in the literature. In investigated dental patients, the mean medial angulation was estimated as $67.5 \pm 5.1^\circ$ where the medial angle of the right process was significantly smaller than that of the left process.^[8] In fifty patients, of both sexes aged 25 - 70 years with symptoms relevant to temporo-mandibular dysfunction (TMD), the anterior angulation average of the SPs was assessed as 20.89° while the medial angulation average was 19.1° on the right side and 19.04° on the left side.^[17]

There are earlier reports showing that the abnormal angulation rather than the elongation of the styloid process might be responsible for irritating various structures neighboring the styloid process leading to Eagles syndrome

Anatomical Variations of the SP:

The SPs exhibit anatomical variations. In a radiological study using a digital camera, the length of the SP was defined in relation to the mandibular foramen and angle. In 35.5% of patients the process projected above the level of the mandibular foramen and in 8.5% of those cases the process was invisible; being partly covered by the images of other skeletal structures. In 58% of cases, the apex of the process was situated between the mandibular foramen and the angle of the mandible, and in the remaining 6.5% of cases it was placed below the mandibular angle. In most of the cases, the SPs on both sides of the skull were symmetrical. In the first two categories (93.5%), the length of the

SP was regarded physiological while in the third category it was described as abnormally elongated.^[18]

On panoramic radiographs of 1,000 dental patients, the patterns of ossification of the SPs were described as elongated (uninterrupted), pseudo-articulated (a single joint appearing as an articulated styloid process), or segmented (interrupted).^[4] There is a study reporting missing of the SP in 5% of adult specimens investigated.^[13] Another study on 3D images had classified the SPs into: solitary SP in 59.4%, duplicated SP in 3.1%, incompletely ossified SP in 21.6%, entirely absent bony SP on one side in 2.5% of individuals, and partially or entirely calcified SHL in 13.4%.^[14]

The Distance from the SP to the Styломастoid Foramen:

The median distance from the base of the SP to the styломастoid foramen was evaluated to be significantly decreased with age: 0.7-0.8 mm in adolescent specimens (11-20 years of age) and usually less than 0.2 mm in adult and old specimens.^[13]

Elongation of the SP and Calcification of the SHL:

Stylohyoid complex syndrome (SHCS) or styloid syndrome includes all lateral neck and/or facial pain conditions that result from an elongated styloid process, calcified stylohyoid ligament, or elongated hyoid bone. Surgical intervention directed at any of these pathologic elements disrupts this complex, relieves tension, and offers relief of patient's symptoms.^[19-21] An abnormally elongated SP or calcified SHL was first described by W. Eagle (1937) and they are now known as Eagle's syndrome (ES). Eagle divided the syndrome into two subtypes: the "classic syndrome" and the "stylo-carotid syndrome".^[22] Symptoms of the classical syndrome include recurrent throat pain, anterolateral neck pain, foreign body sensation in pharynx, dysphagia, referred pain to the ear, or facial pain.^[23-27] It is now stressed that elongation of styloid process alone may not be a risk factor, but deviation of the elongated process anteriorly and medially causes the symptoms of Eagle's syndrome. The neurological symptoms seen in Eagle's syndrome can be due to the approximation of the glossopharyngeal nerve with the stylohyoid ligament.^[17] Elongated styloid process can also cause transient ischaemic attack due to compression of internal carotid artery. It has been reported that elongated styloid process can also cause difficulty during intubation.

CLINICAL IMPLICATIONS

Etiology:

History of trauma, SHL calcification, and formation of bony tissue at the caudal attachment of the SHL are mentioned among the causes of elongation of the styloid process. When there is no history of trauma or surgery, it is called the stylohyoid syndrome.^[28,29] The incidence of stylohyoid ligament calcification was found to be higher in females and to increase with age, being more often at the age of 50-59 years.^[30] Histological examination of the surgically excised stylohyoid ligaments detected calcified hyaline plaques in these ligaments.^[31]

Vascular Impairment:

An enlarged styloid process may also compress the internal carotid artery (styloid-carotid artery syndrome) leading to transient ischemic attack (TIA).^[32-34] Cervical carotid artery dissection (CCAD) may be associated with a longer styloid process, suggesting that mechanical injury exerted by the process.^[35-38] In some cases of Eagle's syndrome, the stylohyoid apparatus can compress the internal and/or the external carotid arteries and their perivascular sympathetic fibers, resulting in a persistent pain radiating throughout the carotid territory.^[39] Intracranial venous hypertension may also result from extrinsic compression of the internal jugular veins at the skull base by the posteriorly located SPs and the condition could be relieved via a decompressive styloidectomy.^[40]

MANAGEMENT

Panoramic radiography is beneficial for revealing of an elongated styloid process and/or ossification of stylohyoid ligaments in patients with or without symptoms and can thus help avoid misunderstanding of the symptoms and hence panoramic radiography is an inexpensive and best imaging modality to view the elongation of styloid process. It also helps to avoid misinterpretation of the symptoms as tonsillar pain or pain of dental, pharyngeal, or muscular origin. Due to the medial angulations of the styloid process and superimposition of other skeletal structures, some inaccuracies may occur when determining the length of the styloid so proper care should be taken while assessing the styloid process. In patients with Eagle's syndrome, dissection and resection of the elongated SP or calcified SHL via an extraoral approach have proved to be simpler, more reliable and with less side effects than when it is performed via the classical transoral, retromolar, para-tonsillar approach.^[41-43]

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